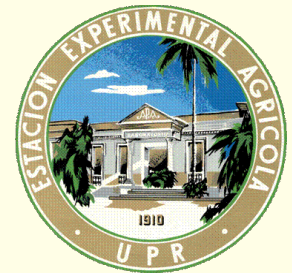


# Soils of Puerto Rico: A Diverse and Valuable Natural Resource



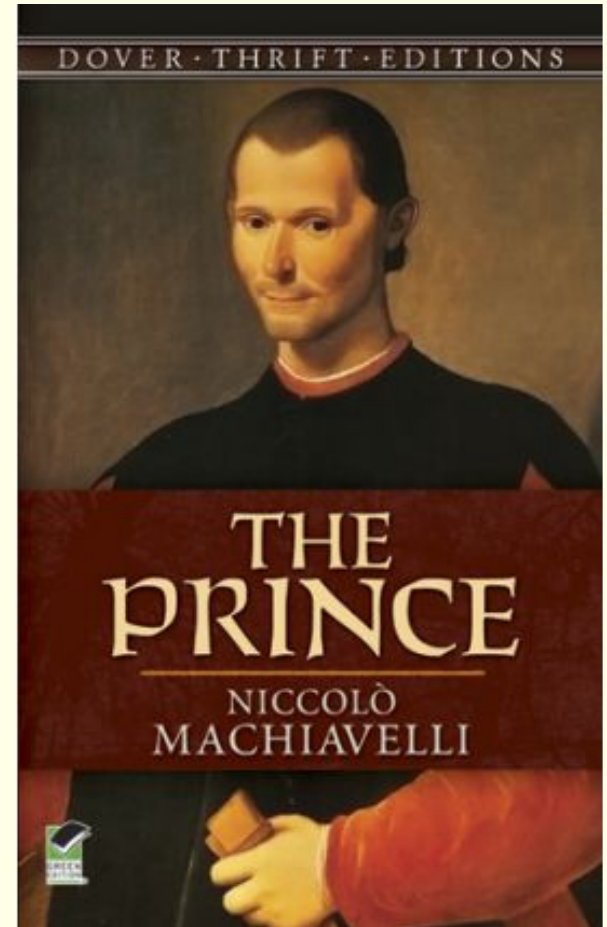
Miguel A. Muñoz  
Professor  
Agro Environmental Science Department  
University of Puerto Rico, Mayaguez



# The Prince and the Art of Warfare

## Nicolás Maquiavelo (1469 – 1527)

The Prince was written in 1513 by Niccolo Machiavelli and dedicated to Lorenzo de Medicis. His political views were centered in the state administration and in the psychological thoughts of their leaders or governance authorities.



# The Prince and the Art of Warfare

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- Macchiavelli states in his book, that a good leader ... *“learns something of the nature of localities, and gets to find out how the mountains rise, how the valleys open out, how the plains lie, and to understand the nature of rivers and marshes, and in all this to take the greatest care. Which knowledge is useful in two ways. Firstly, he learns to know his country, and is better able to undertake its defense;*

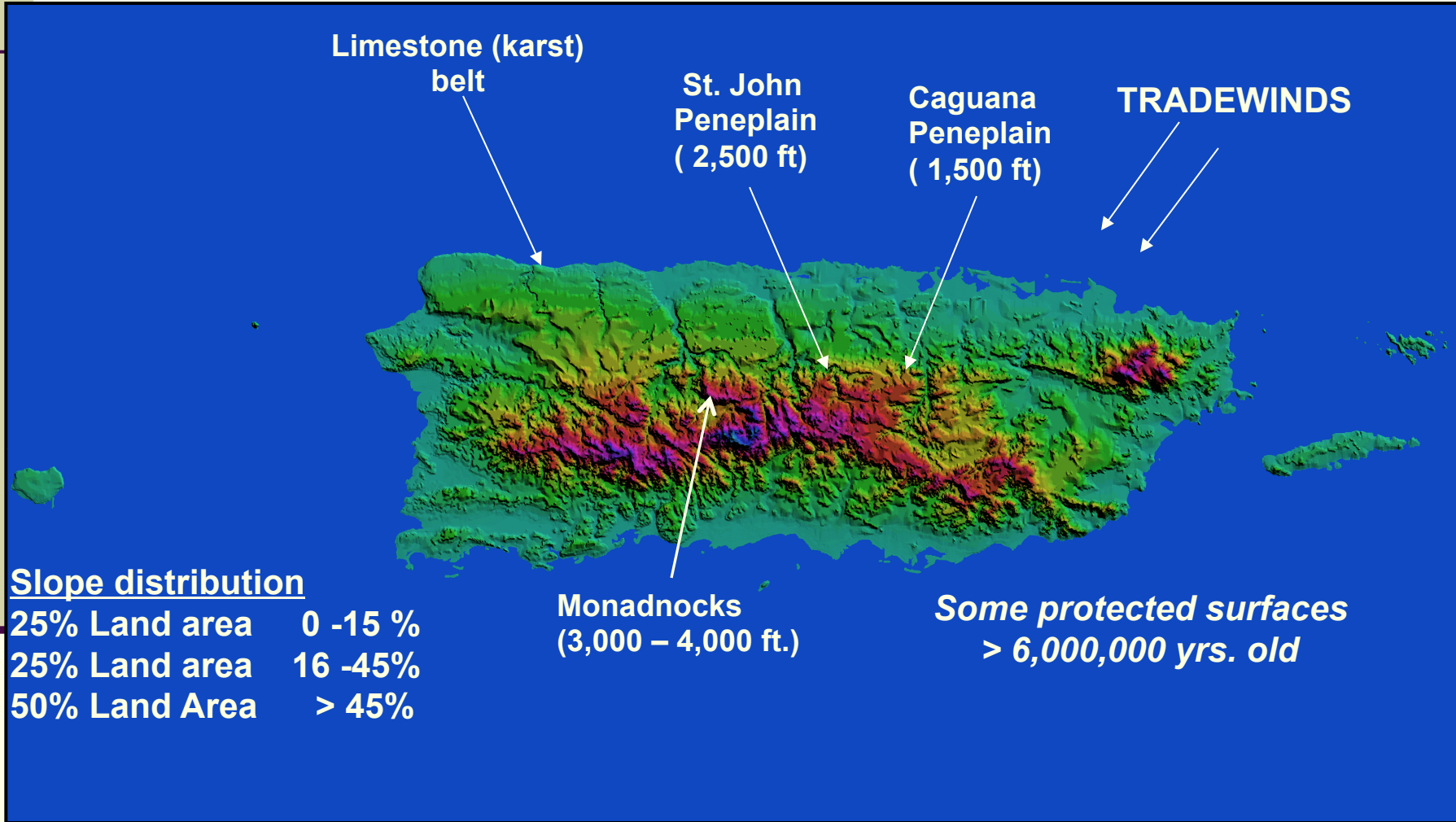
# The Prince and the Art of Warfare

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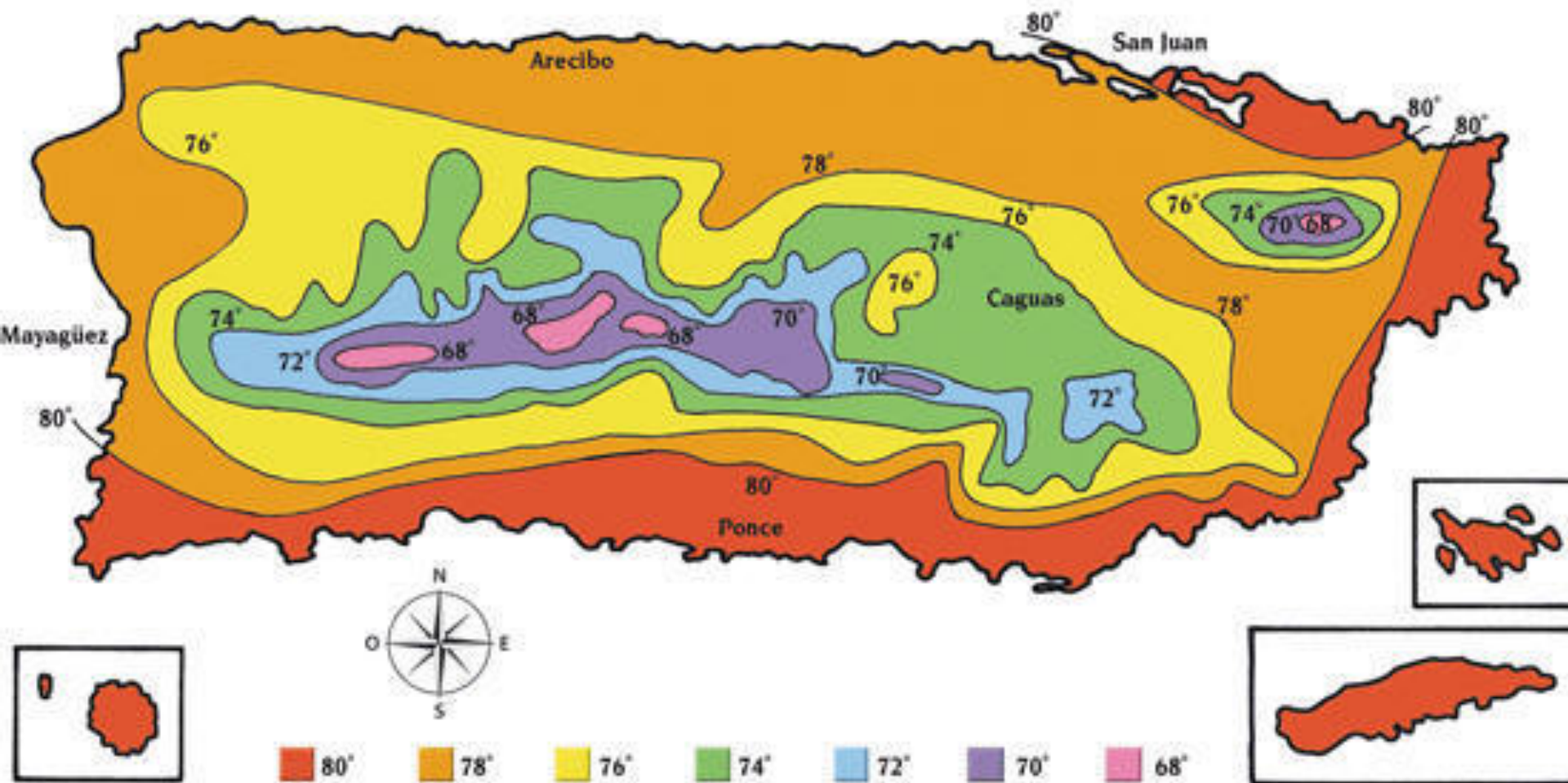
- *afterwards, by means of the knowledge and observation of that locality, he understands with ease any other which it may be necessary for him to study hereafter; because the hills, valleys, and plains, and rivers and marshes that are, for instance, in Tuscany, have a certain resemblance to those of other countries, so that with a knowledge of the aspect of one country one can easily arrive at a knowledge of others.”*



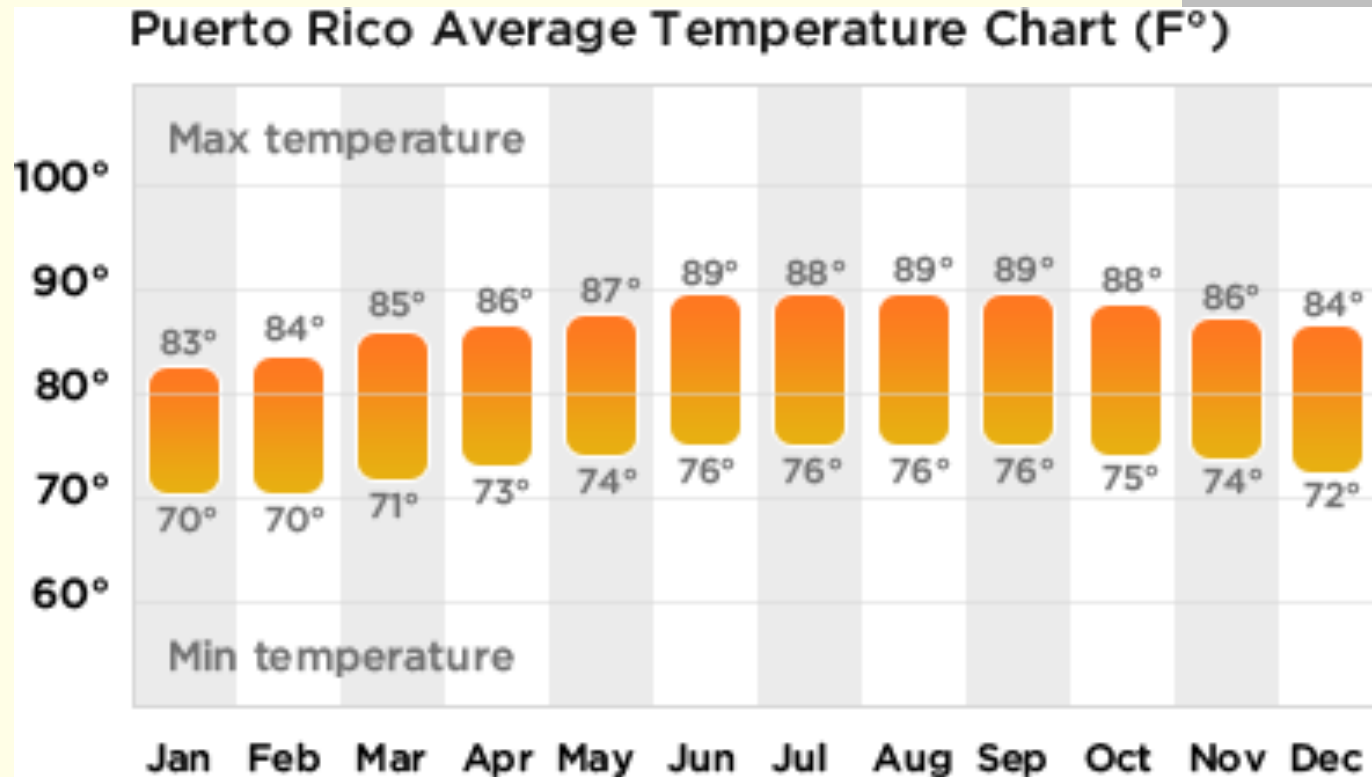
# Physiographic Features of Puerto Rico



# Average Temperatures in Puerto Rico

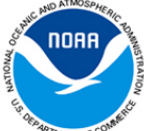


# Soil Temperature Regimes



**Isohyperthermic: > 22 °C (>72 °F) at lower elevations**

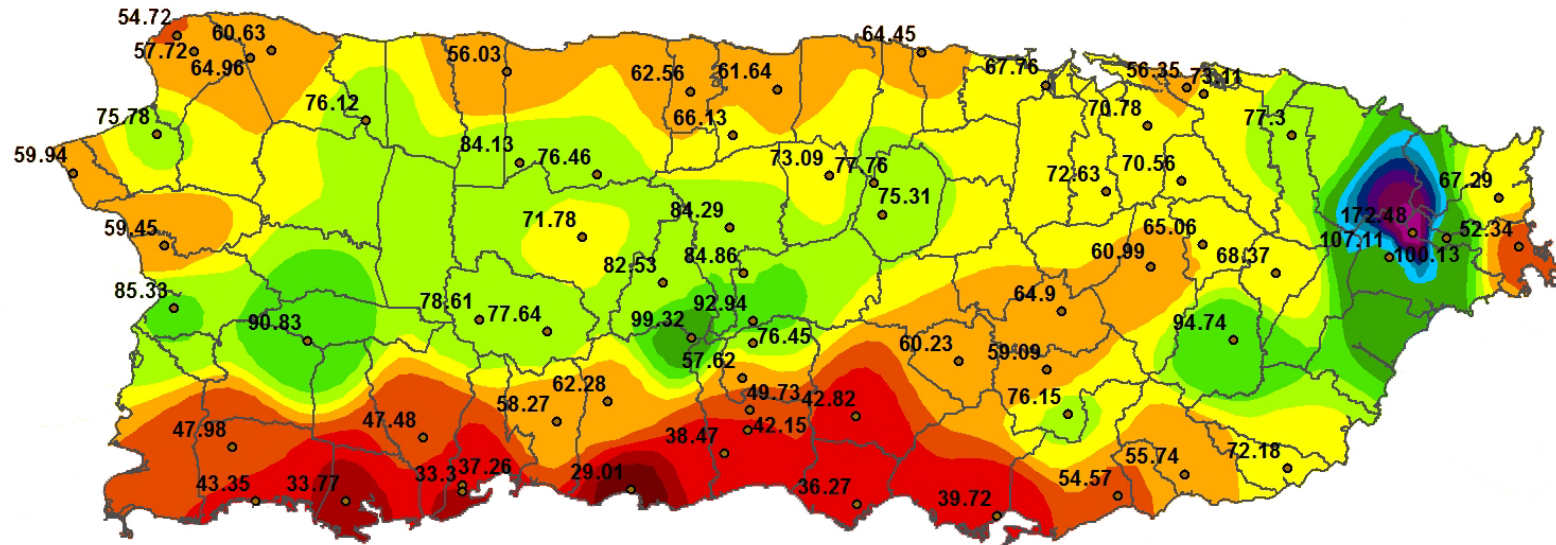
**Isothermic: 15 - 22 °C (59 - 72 °F) at higher elevations**



# MEAN ANNUAL PRECIPITATION 1981 - 2010



PUERTO RICO



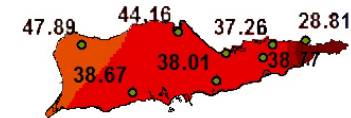
## Annual Precipitation (Inches)

25 - 30	55 - 60	85 - 90	115 - 120	145 - 150
30 - 35	60 - 65	90 - 95	120 - 125	150 - 155
35 - 40	65 - 70	95 - 100	125 - 130	155 - 160
40 - 45	70 - 75	100 - 105	130 - 135	160 - 165
45 - 50	75 - 80	105 - 110	135 - 140	165 - 170
50 - 55	80 - 85	110 - 115	140 - 145	170 - 175

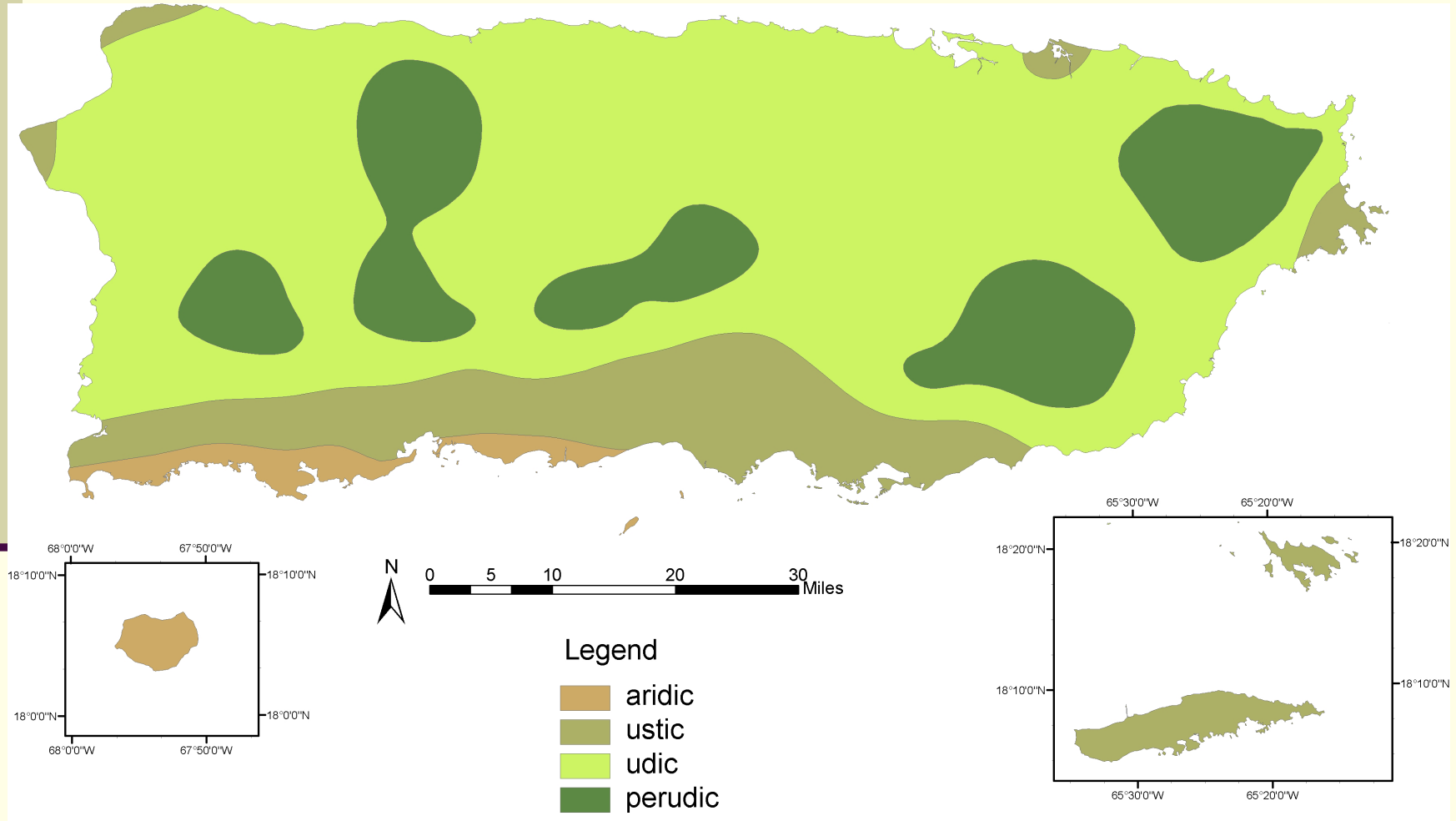
ST. THOMAS / ST. JOHN



ST. CROIX

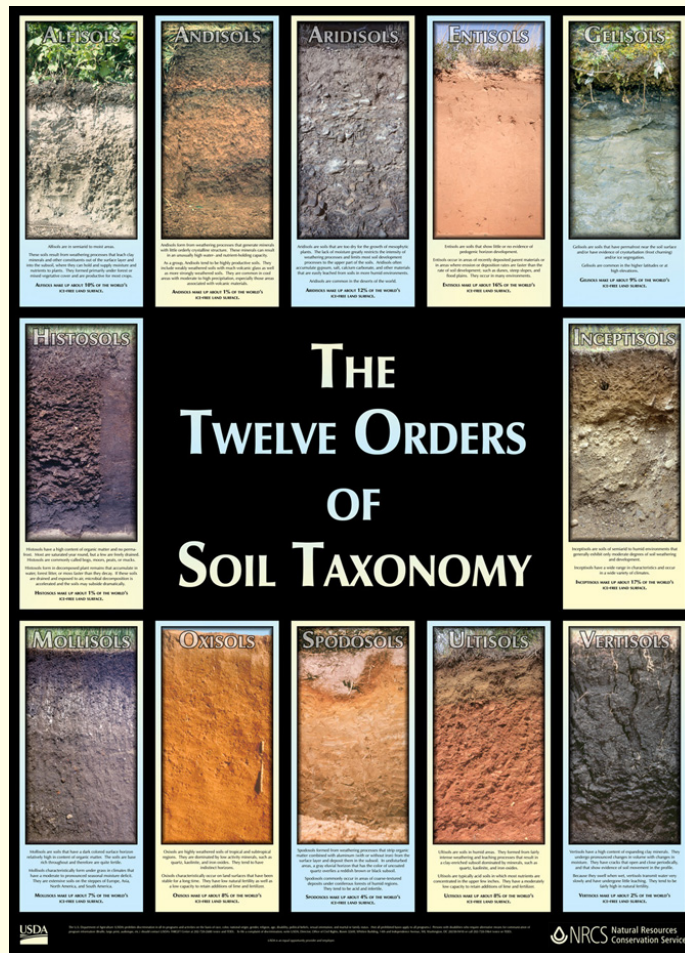


# Soil Moisture Regimes



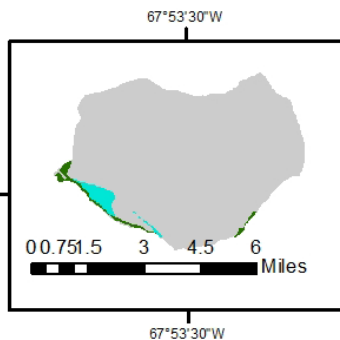
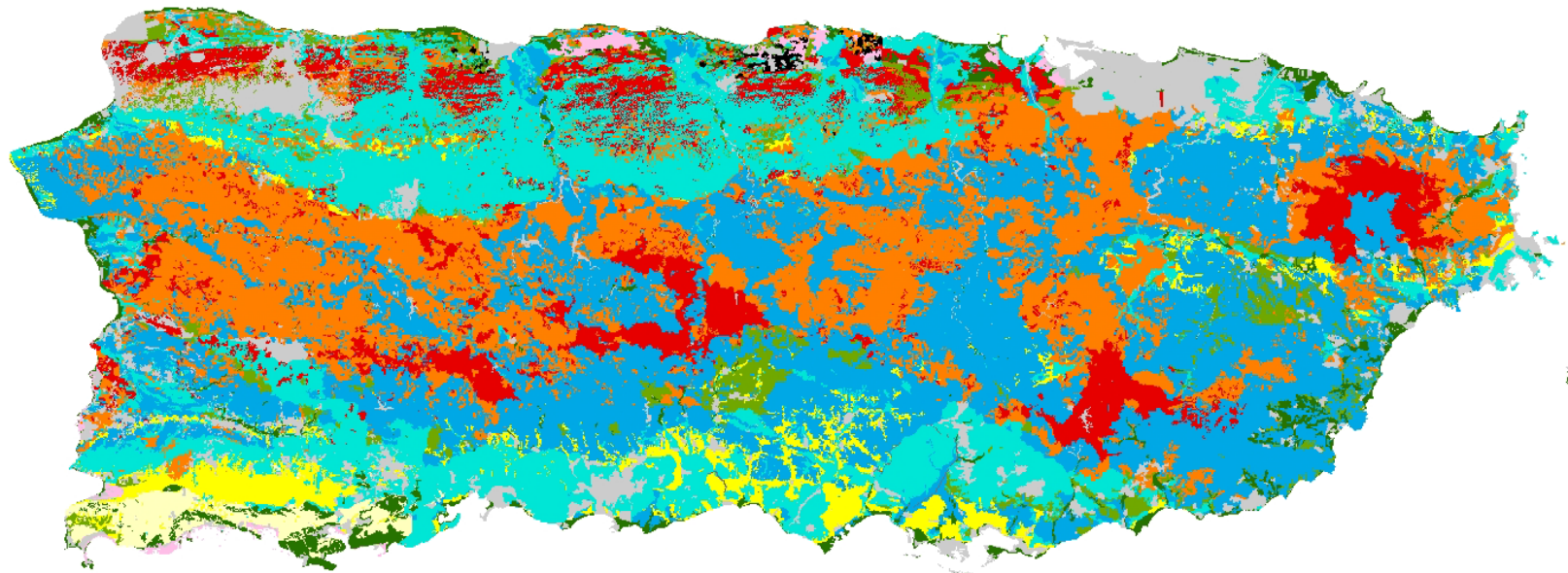


# Soils Orders in Puerto Rico

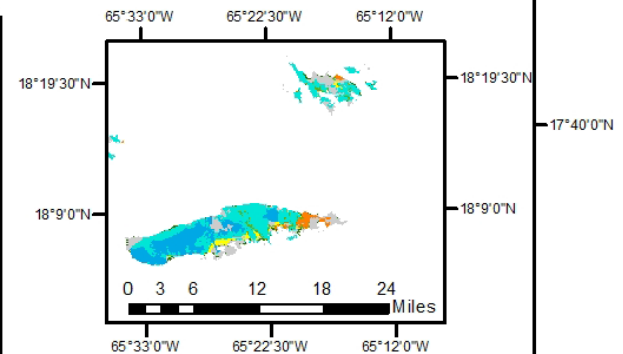
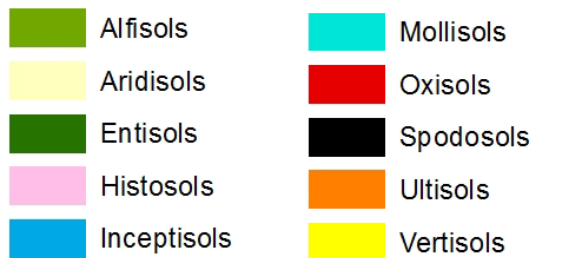


- Puerto Rico has 10 of the 12 Orders recognized by in Soil Taxonomy.
- No Gelisols – Tropical conditions
- No Andisols – No recent volcanic activity

# Soil Orders of Puerto Rico



## Legend



Map Created by: Manuel Matos, MLRA SSL  
Mayaguez MLRA Soil Survey Office, April 2016

# Land Area Distribution of Soils Orders in Puerto Rico

Order	Area (ha)	% Soil Area	% Total Area
Inceptisols	274,427	35.13	30.50
Ultisols	177,934	22.78	19.78
Mollisols	139,473	17.85	15.50
Oxisols	69,963	8.96	7.78
Vertisols	38,171	4.89	4.24
Entisols	32,736	4.19	3.64
Alfisols	32,133	4.11	3.57
Aridisols	9,681	1.24	1.08
Histosols	4,924	0.63	0.55
Spodosols	1,723	0.22	0.19
Other Land	109,205	N/A	12.53
Water	6,323	N/A	0.70



# Distribution of Soils According to Taxonomic Categories

■ Orders	10
■ Suborders	32
■ Great Groups	66
■ Subgroups	146
■ Families	215
■ Series	214



**Bayamón Series**  
**Representative Soil of Puerto Rico**

# Soil Orders and Soils Series in Puerto Rico

Soil Order	Number of Series
Inceptisols	46
Ultisols	28
Mollisols	36
Oxisols	25
Vertisols	19
Entisols	17
Alfisols	18
Aridisols	14
Histosols	8
Spodosols	3
<b>Total</b>	<b>214</b>

# Inceptisols (35% Soil Area)

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**Inceptisol Landscape – Mountain Region**



# Múcara Series (Dystric Eutrudepts)



- Moderately deep soils, well drained, formed from residuum that weathered from basalt lava and breccia. The landscape is hills and mountains. Slope ranges from 5-60 percent.

# Inceptisol in an Alluvial Landscape

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# Coloso Series (Vertic Endoaquepts)

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- Very deep, somewhat poorly drained soil, with slow permeability. Formed on stratified loamy and clayey alluvial deposits. Occupy river valleys and flood plains. Slope ranges from 0 to 2 percent.

# Ultisols (22.8 % Soil Area)

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# Humatas Series (Typic Haplohumults)

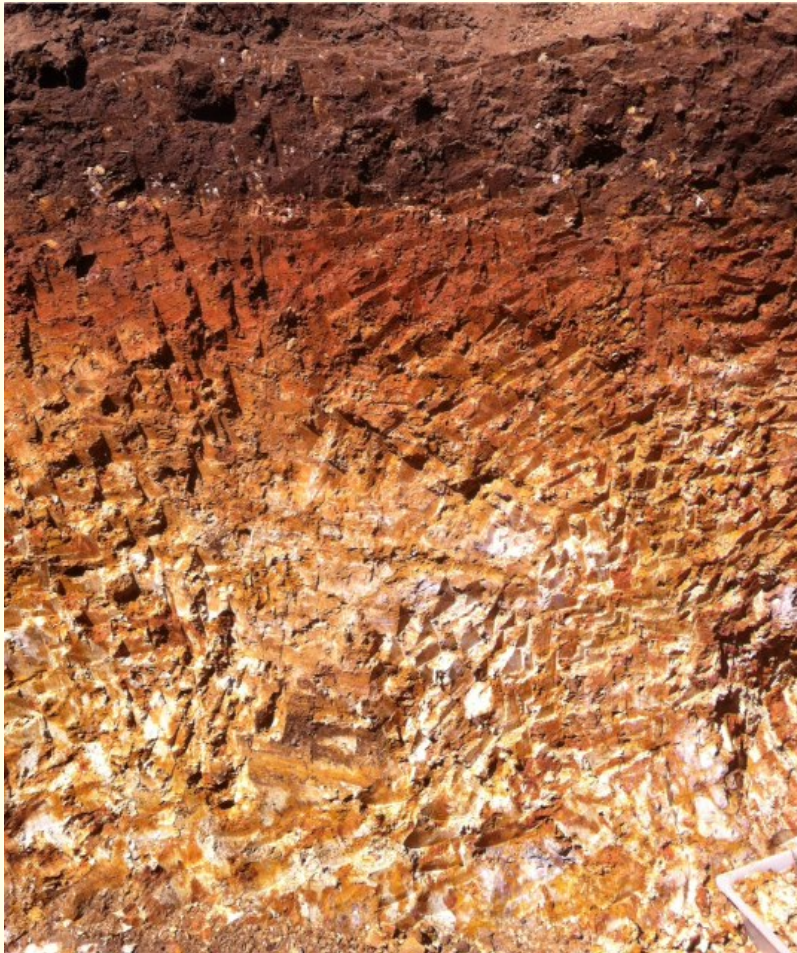


- Very deep, well-drained soils with moderately slow permeability. Formed in clayey and loamy residuum weathered from igneous bedrock. Occupy ridges, hillslopes and mountain slopes. Slope ranges from 12 to 60 percent.



# Mariana Series (Typic Haplohumults)

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- Very deep, well-drained soils with moderate permeability. Formed in colluvium and residuum that weathered from basalt lava and tuff. Occupy ridges and hillslopes. Slope ranges from 12 to 40 percent.

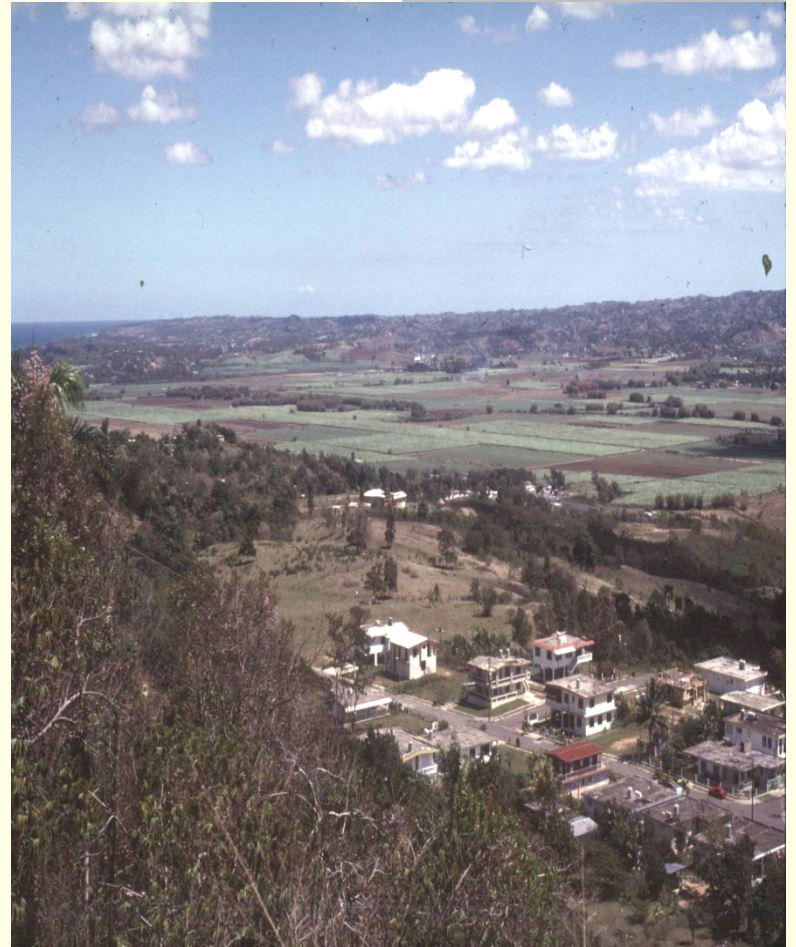


# Mollisols (17.9% Soil Area)

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**San Antón Landscape**



**Toa Landscape**

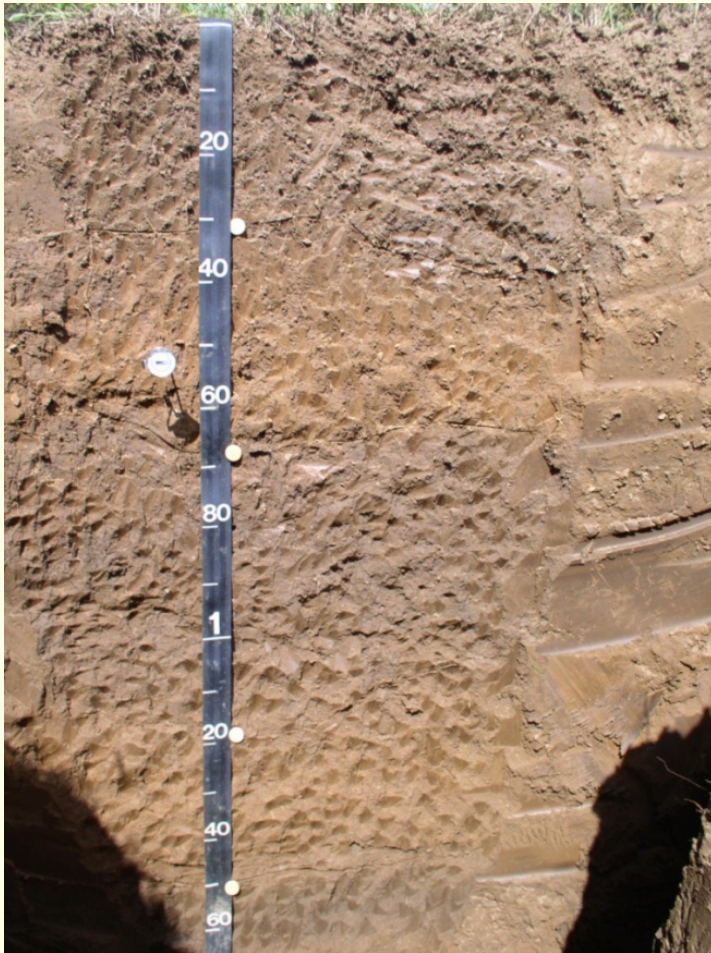
# San Antón Series (Cumulic Haplustolls)



- Very deep, well drained soils of moderate permeability, formed on stratified alluvial deposits of mixed origin. Occupy river valleys and flood plains. Slopes 0 to 2 percent.



# Toa Series (Fluvaquentic Hapludolls)



- Very deep, well drained soils of moderate permeability. Formed from stratified alluvium of mixed origin. Occupy river valleys and flood plains. Slopes 0 to 2 percent.

# Soller Series (Typic Haprendolls)



- Moderately deep soils, well drained. Formed in fine textured residuum derived from limestone. Occupy uplands with slopes from 5 to 60 percent. Mainly used for pastures.



# Soller Lanscape

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# Oxisols (9.0% Soil Area)



- Stable remnants of St. John Peneplain at Barranquitas Puerto Rico. Catalina series (Typic Hapludox) occupy side slopes and hilltops. Formed in fine textured residuum of volcanic rocks. Slopes range from 4 to 12 percent.

# Bayamón Series (Typic Hapludox)



- Deep, well-drained soils on upland and coastal plains. These soils formed in fine-textured sediments of mixed origin. The slope ranges from 2 to 12 percent.

**Representative soil of Puerto Rico.**



# Bayamón Lanscape Robusta Coffee

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# Oxisol on Weathered Serpentine



# Nipe Series (Anionic Acrudox)



- Deep, well-drained soils that are moderately to rapidly permeable. These soils are on mesa-like ridgetops. Formed in material weathered from serpentinite. The slope ranges from 5 to 20 percent.

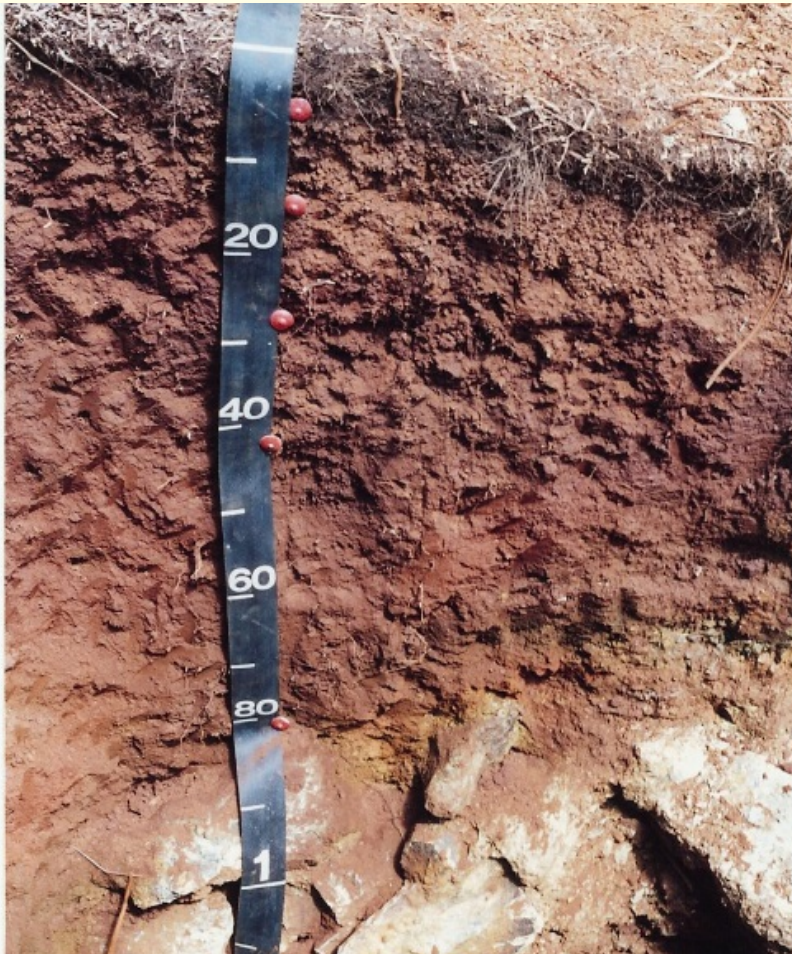


# Nipe Series Landscape

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# Rosario Series (Typic Hapludox)



- Shallow, well-drained soils with moderate permeability, formed in iron rich residuum that weathered from serpentinite bedrock and occupy ridges, hillslopes, and mountain slopes. Slope ranges from 12 to 60 percent.



# Rosario Series Landscape

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# Vertisols (4.9% Soil Area)

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**Vertisol Landscape Lajas Valley**

# Fraternidad Series (Typic Haplusterts)



- Very deep, moderately well-drained. Very slow permeability. Formed in clayey alluvial sediments weathered from igneous, metamorphic, and sedimentary rocks. Occupy fan skirts and basins. Slope from 0 to 5 percent.



# Cartagena Series (Sodic Haplusterts)



**Gilgai relief**

- Very deep somewhat poorly drained with slow permeability. Formed in alluvium and marine sediments. Occupy basins and fan skirts. Slope 0 to 2 percent.

# Entisols (4.1% Soil Area)



**Entisols Landscape near Dorado, Northern Puerto Rico**



# Reilly Series (Mollic Udifluvents)



- Gravelly, very deep, excessively drained soils of rapid permeability. Formed in stratified alluvial deposits of mixed origin. Occupy floodplains and river banks. The deposits are coarse-textured and stratified with sand, gravels and cobbles. Slope ranges from 0 to 2 percent.

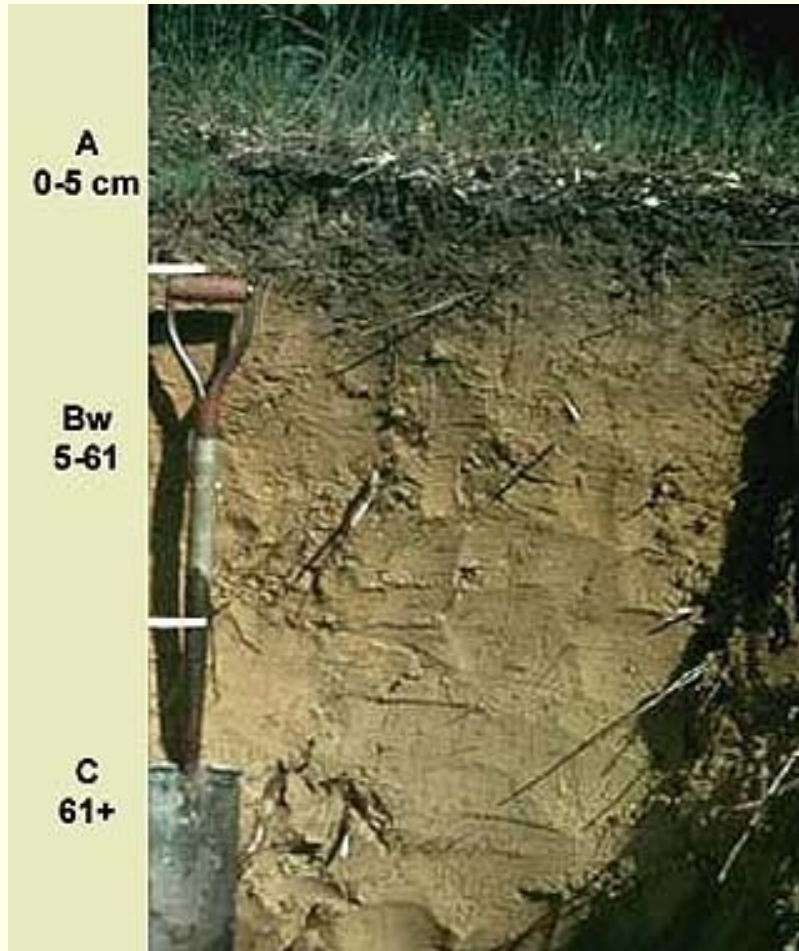


# Reilly Series Landscape

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# Cataño Series (Typic Udipsamments)



- Very deep, excessively drained soils formed in beach sand deposits consisting of shell fragments, quartz grains and igneous rock fragments. Occupy coastal plains. Slope ranges from 0 to 2 percent.



# Psamment Landscape, Loiza Puerto Rico

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# Alfisols (4.1% Land Area)

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**Tanamá Landscape**

# Tanamá series (Lithic Hapludalfs)

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- Shallow and well drained soils, formed in fine texture residuum derived from hard limestone. Occupy uplands and are used mainly for pasture and woodland. Slope ranges from 2 to 40 percent.



# Santa Marta Series (Typic Kanhapludalfs)



- Moderately deep, well drained soils with moderate permeability. Formed in residuum that weathered from serpentinite bedrock. Occupy hills and hillslopes. Slope ranges from 20 to 40 percent.



# Aridisols (1.2% Soil Area)

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**Altamira Series Landscape**

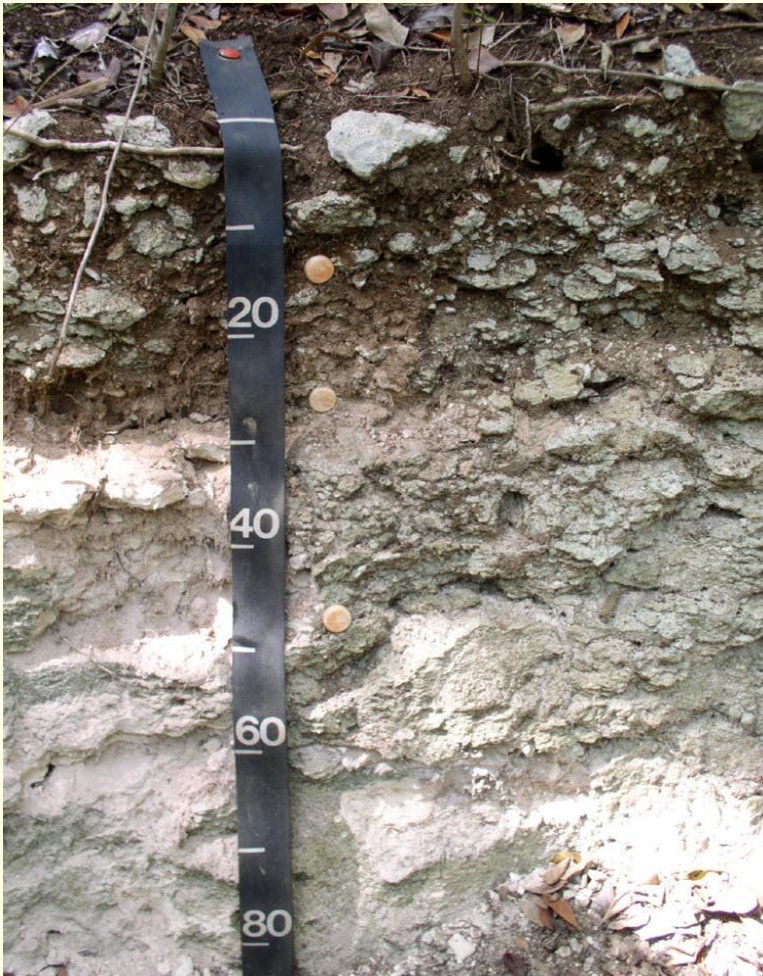
# Altamira Series (Typic Haploclacids)



- Deep, well-drained soils of moderate permeability. Formed in material that weathered from soft limestone bedrock. Occupy hills and hillslopes.



# La Covana (Lithic Petrocalcids)



- Shallow, well drained soils of very slow permeability. Formed in material weathered from limestone bedrock. Occupy hills in ridges and hillslopes. Slope ranges from 12 to 40 percent.

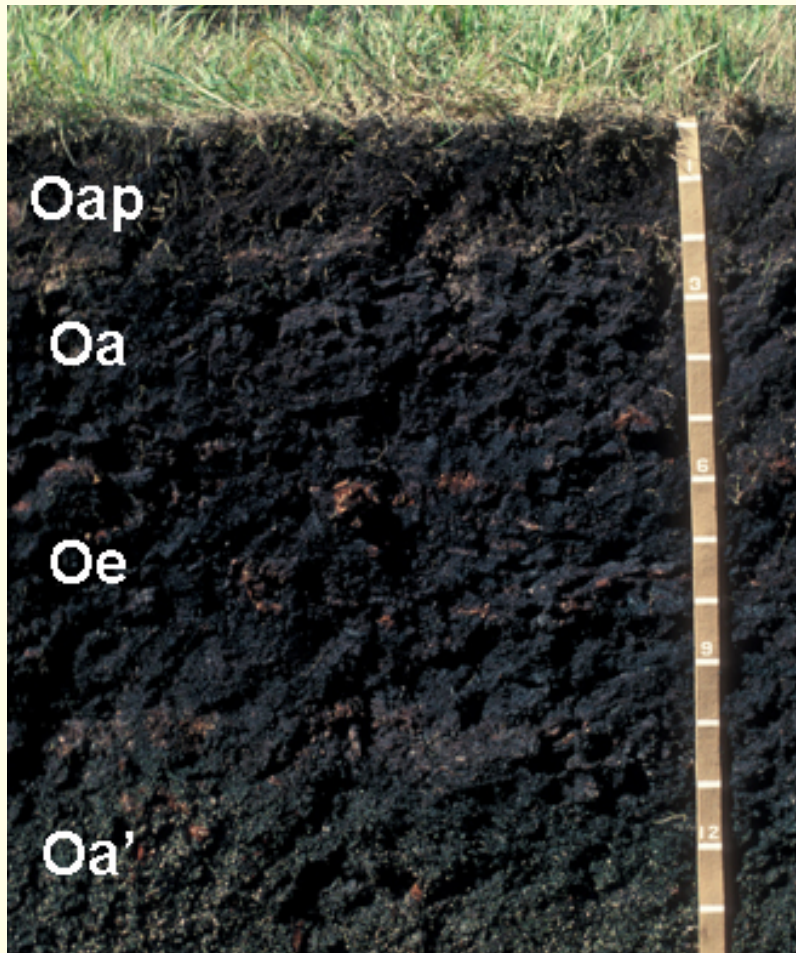


# Histosols (0.6% Land Area)



**Caño Tiburones Wetland Reserve**

# Tiburones Series (Typic Haplosaprists)



- Deep and poorly drained soils, on coastal plains and on flood plains. Formed in residuum of highly decomposed plant tissue. This series can be found at the Caño Tiburones Wetland Reserve.



# Los Peñones (Lithic Udifolists)



- Very shallow, well drained, rapidly permeable soils on side slopes and stable ridge tops of the limestone outcrop hills and mountains. Formed in organic material overlying limestone. Slopes range from 60 to 90 percent.



# Spodosols (0.2 % Land Area)

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**Corozo Series (Typic Alorthods)**



# Corozo Series (Typic Alorthods)



- Deep and well drained soils on coastal plains. Formed in coarse textured quartz sediments. Mainly used for pangola grass and coconuts or in native pasture. Slope range from 2 to 12 percent.



# Landscape Corozo Series

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# Algarrobo Series (Entic Alorthods)

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- Deep and excessively drained soils found in coastal plains. Formed in coarse textured sediments with a high content of quartz and are over coastal plain clays. Slopes range from 2 to 12 percent.



# Landscape Algarrobo Series

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# Nipe (Very Fine, ferruginous, isohyperthermic Anionic Acrudox)



Soil science is a fascinating field of study. These are hands that have felt the magic and beauty of Nipe soil.



Class Agro. 5008 – Soils of Puerto Rico. Nipe soil Cerro Las Mesas, Mayaguez, Puerto Rico (March, 2015)